AMENDMENTS TO THE SPECIFICATION

Vehicle suspension system, particularly for road and off-road vehicles

The present invention relates to a vehicle suspension system, particularly for road and off-road vehicles, such as trucks, buses and military vehicles, including tanks, and first of all for those vehicles whose weight and dynamical loads vary within a broad range during the operation process.

The main function of vehicle suspension is to reduce vibrations transferred to a vehicle body by vehicle wheels. The suspension is a set of elements connecting the vehicle wheels with the vehicle frame or body. Suspensions of automotive vehicles are fitted with steel springs such as leaf springs, coil springs, torsion bars, as well as solid rubber elements and pneumatic springs and hydro-pneumatic elements.

Leaf springs are made of elastic steel flat bars. The leaf spring, supported in the middle and loaded on both ends, is subject to deformation and simultaneously works against the forces of elasticity.

Coil springs are made of steel spring wire. They are lighter and easier to assemble than leaf springs but unable to transfer side forces, hence additional elements are necessary to hold the vehicle axle.

Torsion bars are steel springs made in the form of rod, tube or flat bar pack, one end of which is anchored e.g. in a vehicle frame while the other one is twisted by an arm of a vehicle wheel.

Pneumatic springs are built in the form of two or three-fold bellow manufactured of synthetic rubber reinforced with cord plait and tightened in metallic holders. Pneumatic springs work utilizing pressure of compressed air contained therein. They are used in buses and trucks as well as in off road vehicles. There are also hydro-pneumatic suspensions, in which the elastic medium is a compressed gas contained in a chamber.

Further compression of the gas results from the action of a piston, which follows the movement of a vehicle wheel.

The spring rate of steel springs is, in general, constant. Thus the damping characteristic of most prior-art vehicle suspension systems using such a spring is linear or nearly linear, which is their major disadvantage. Some of steel springs, e.g. coil springs, can be made progressive, however damping characteristic of vehicle suspension using such springs cannot be freely shaped and remains remarkably inferior to that of the air spring.

Some unconventional vehicle suspension systems providing non-linear damping characteristic and means for adjusting it are known from prior art. For example the International publication WO-A-96 11815 of the International Application PCT/CA 95/00570 discloses a suspension system, in which the suspension arm rotates roller carriers, the rollers contained therein follow cam surfaces, which in turn force a spring supports to move axially and to compress the spring. The US patent No. 3,157,394 granted to Mr. O. K. Kelly in 1964 provides another example of suspension with a cam mechanism, a number of in turn actuated Belleville springs and non-linear non-differentiable characteristic. However non-linearity of damping characteristic of these suspensions is achieved by engaging springs through a cam mechanism, and means for adjusting the characteristic are shape of the cam, its position relative other elements of the suspension mechanism and nuts to regulate the initial length of the spring. Consequently, these suspensions are exceedingly complicated, of questionable durability and reliability, unable to cope with large loads, and means for adjusting damping characteristic of them are completely unsatisfactory.

A vehicle suspension, according to the present invention, is a purely mechanical device. Non-linearity of its damping characteristic and means for adjusting it to specific requirements are derived directly from the kinetic of the four bar mechanism. It contains no foreign ad hoc incorporated parts e.g. cams and features a compact and robust structure. In fact the structure of the mechanism of the suspension according to the present invention is the strongest possible as its moving parts occupy the whole internal space of its body. Thus it can cope with large loads and the capacity/weight ratio would be better than that of all kinds of known suspensions. It uses only standard springs, while it provides a damping characteristic, which betters that of hydro-pneumatic suspensions. Moreover the construction of the suspension, according to the invention, enables its characteristic to be freely chosen through the choice of the geometric parameters of the mechanism comprised therein.

The manufacturing technology of the suspension according to the invention is simple and inexpensive. Moreover, the suspension provides the possibility of the relative position between elements connecting the suspension unit with vehicle wheels and a spring to be freely adjusted.

The invention solves the problem of constructing a vehicle suspension of non-linear characteristic using springs of linear characteristic. By non-linear characteristic is meant non-linear and differentiable dependence of suspension stiffness on vehicle axle flex.

The object of the invention is to provide a new type of vehicle suspension system destined for new vehicles, particularly for road and off-road ones, which also can be assembled in existing vehicles during overhauls, e.g. in tanks, and which improves substantially the shock absorption within the whole range of dynamical loads and vehicle weight variations.

The essence of the vehicle suspension system, according to the present invention, is that it comprises at least one flat or spatial four-link mechanism, three kinematic pairs of which are rotational ones, while the fourth one is either a rotational or a sliding one, and the two links of said mechanism are made in the form of eccentric and one link is made in the form of eccentric or slider, wherein one link of said mechanism is coupled with a vehicle wheel, another link of the mechanism is coupled with a spring, and the whole mechanism is fastened to a vehicle frame through yet another link, to obtain a non-linear dependence of deformation of the spring on an axle flex.

A good result is obtained when said suspension system, as four links of its mechanism, comprises a shaft fitted with an eccentric, which is coupled rotationally with an intermediate eccentric, the latter being coupled rotationally with a disc, while the shaft and the disc pivot directly in the mechanism body. The body is fastened to a vehicle frame. The shaft, in turn, is coupled rigidly with the vehicle wheel arm, and the disc is coupled with one end of a spring, the other end of which is fastened to the body of the mechanism or directly to the vehicle frame. In this arrangement, the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.

A good result is also obtained when the suspension system, as its four links comprises a shaft fitted with an eccentric which is coupled rotationally with an intermediate eccentric which, in turn, is coupled rotationally with a disc, while the shaft and the disc pivot directly in the mechanism body, the latter being fastened to a vehicle frame. Besides, the disc is coupled rigidly with the vehicle wheel arm, and the shaft is coupled with one end of a spring, the other end of which is fastened to the body or directly to the vehicle frame.

In this arrangement the axes of rotation of all the kinematic pairs of the suspension mechanism are parallel to each other.